Influence of Biochar Amendment on Greenhouse Gas Production in Two Fertilized Prairie Soils

Ryan Hangs, Hasan Ahmed, and Jeff Schoenau

Department of Soil Science, University of Saskatchewan, Saskatoon, SK

INTRODUCTION

- The utility of biochar to improve numerous soil physical, chemical, and biological properties (e.g., bulk density, cation-exchange capacity, pH, microbial community activity, etc.) is well known.
- However, previous research has concentrated on tropical soils (old and highly-weathered, acid pH, low organic matter content and fertility), while the influence of biochar application on the relatively young and fertile soils of Saskatchewan is largely unknown.

OBJECTIVE

- Determine the effect of a willow (*Salix*) biochar soil amendment on the measured N_2O, CO_2, and CH_4 emissions from two prairie soils having contrasting organic matter content, with and without fertilizer N addition, over a six-week incubation period.

MATERIALS & METHODS

- Orthic Black Chernozem (Meota Association) and Brown Solodized Solonetz (Kettlehut Association) loam soils were sampled from the Ap horizon, dried, and thoroughly homogenized prior to use.
- Treatments: control; willow biochar (20 Mg/ha), produced using slow pyrolysis (300-600 ^oC); urea (100 kg N/ha); biochar plus urea.
- Pots were maintained at 75 % field capacity and incubated (20 ^oC) for six weeks.
- Variables measured included: PRS™-probe NO_3^--N and NH_4^+-N supply rates, along with weekly N_2O, CO_2, and CH_4 emissions.

RESULTS

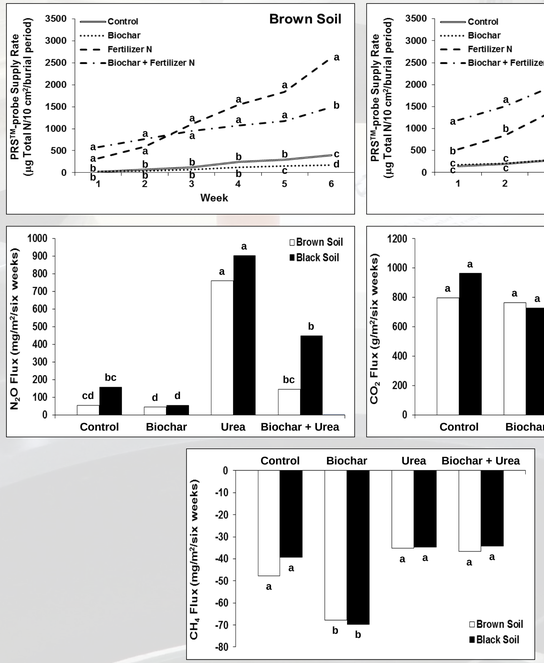

Figure 1. Mean (n = 5) cumulative total N (NO_3^--N + NH_4^+-N) supply rates and N_2O, CO_2, and CH_4 fluxes during a six-week incubation following willow biochar addition (20 Mg/ha) to soils having contrasting organic matter content, with and without fertilizer N (100 kg N/ha). Total N supply rates (within week) and gas fluxes with the same letter are not significantly different (P >0.05) using LSD.

DISCUSSION & CONCLUSION

- The ability of biochar to decrease soil N availability in the Brown soil by the end of the incubation, with or without fertilizer N, may be due to immobilization by adding a biochar with an 82 and < 1 % carbon and nitrogen content, respectively. Conversely, the initially higher soil N supply in the Black soil with biochar plus urea compared to urea only was surprising and could reflect enhanced urea hydrolysis in the presence of biochar and/or enhanced biochar N release caused by the fertilizer.
- The decreased N_2O emissions following biochar addition, with (both soils) or without (Black soil) fertilizer N, is likely due to its influence on soil N availability.
- The capacity of biochar to make both soils stronger CH_4 sinks could result in part from the production of a more favourable environment for methanotrophic bacteria activity.
- The lack of differences in CO_2 fluxes, with or without fertilizer N, suggests that the biochar effect on N_2O and CH_4 fluxes may be largely the result of its influence on soil enzyme activity.
- Further research is required comparing biochars with different physical/chemical properties (e.g., C:N, surface area, CEC, etc.), along with studies verifying the operative processes.

ACKNOWLEDGEMENTS

- Many thanks to the Saskatchewan Agriculture Development Fund for funding; Western Ag Innovations Inc. for supplying the PRS™-probes; M. Providenti (SRC) for providing the biochar; and C. Fatteicher, T. King, F. Krijnen, D. Richman, M. St. Arnaud, and R. Urton for their logistical support.